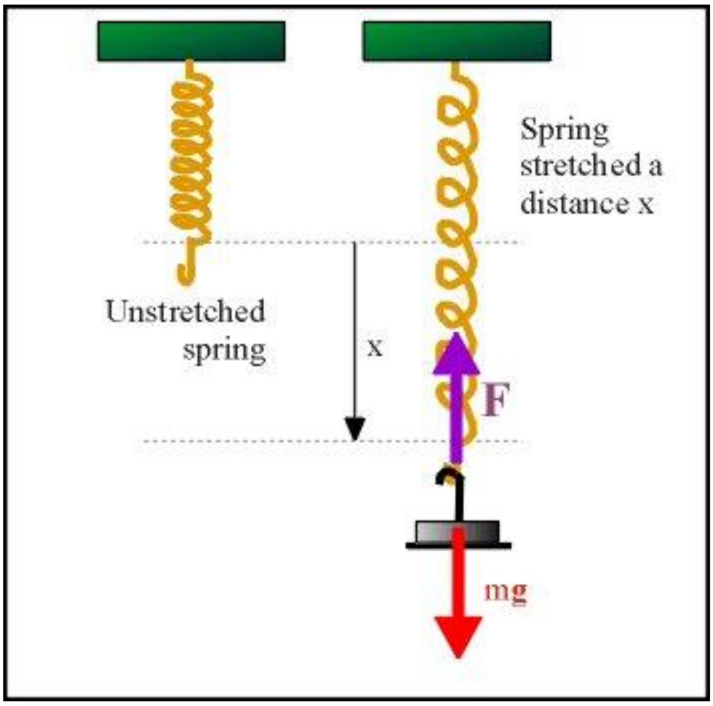
Springs

Physicists seem to pay a lot of attention to springs. But why!??! Aside from the spring on the veranda door, the one on the pogo stick that's been lying in the garage since 1962, and the springs in the shock absorbers on your car, they don't seem to play a big part in the world around us. However, physicists recognize that springs are useful models for other phenomena.

Part of the reason that a spring makes a good model for other phenomena is that it's *simple*. The force law for a spring looks like this:

$$\mathbf{F} = -k\mathbf{x}$$

where F is the force exerted by a spring, x is the displacement of the end of the spring from its equilibrium position, and k is what is called the spring constant.



The spring constant is a measure of the "stiffness" or "strength" of a spring. To determine this spring constant, you could do the following: hang the spring from some sort of support and note its un-stretched length. Now add some mass to one end of the spring. The spring will stretch and come into equilibrium at a length x beyond the spring's un-stretched length. The masses are pulled down by force of gravity and pulled up by the spring force. The two forces balance, and this means that the force of the spring on the masses is equal to mg, the weight of the masses. Adding more mass will further stretch the spring. By measuring and plotting the spring force, F, against the stretching of the spring, x, you should get a straight-line graph with slope k

Determine the Spring Constant

Hooke's Law states that the restoring force of a spring is directly proportional to a small displacement. In equation form, we write

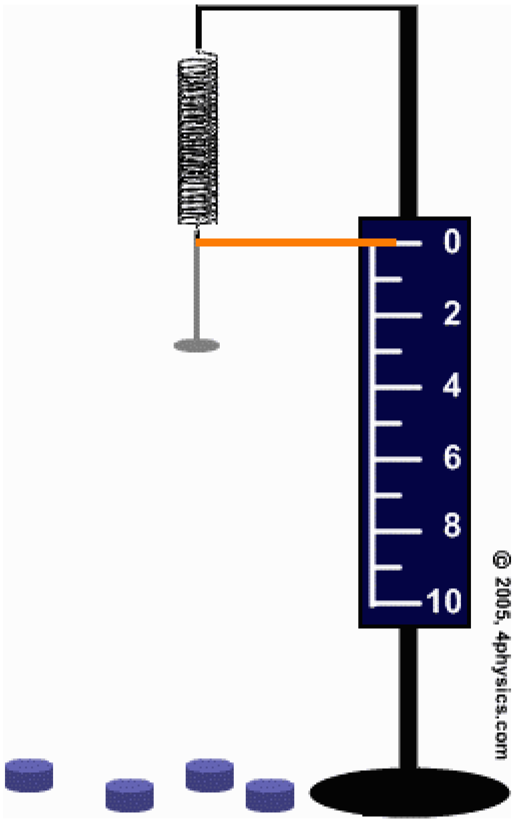
$$F = -kx$$

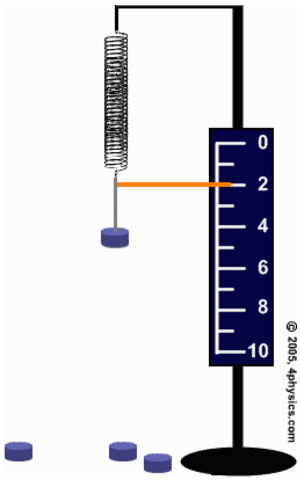
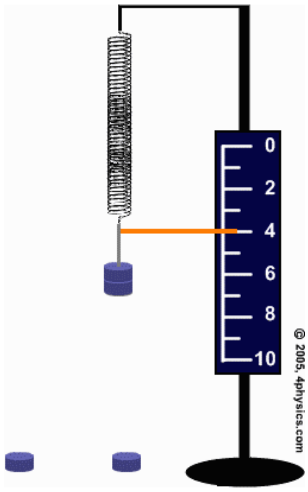
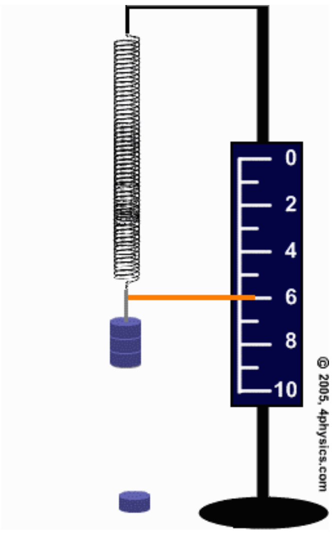
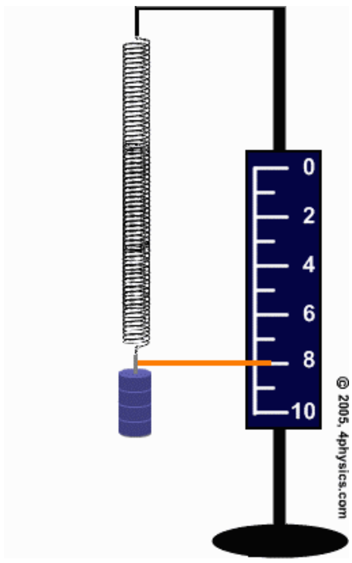
where x is the size of the displacement. The proportionality constant k is specific for each spring.

The object of this virtual lab is to determine the spring constant k.

Displacement is measured in centimeters. Each of the blue weights has a mass of 50 grams. The gray virtual weight hanger has no mass.

Snapshots of the lab are found in the four figures that follow.

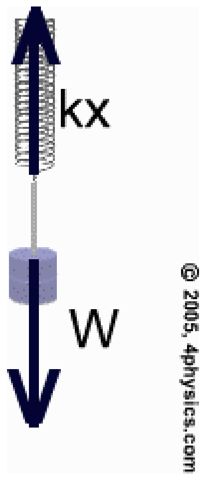


 50 grams mass is 2 cm displacement.	 100 grams mass is 4 cm displacement.
 150 grams mass is 6 cm displacement.	 200 grams mass is 8 cm displacement.

Mass (grams)	Displacement (cm)
50	2
100	4
150	6
200	8

These data have been entered into the table to the left.

For each snapshot above the downward pull of gravity is balanced by the upward pull of the spring. A force or free-body diagram of this is shown on the right-hand side.



Note that the restoring spring force is given by Hooke's Law as kx.

This equilibrium can be expressed as

$$W = kx.$$

W is the weight of the added mass. Therefore, the spring constant k is the slope of the straight line W versus x plot.